PATENT **Docket No. RSW920030089US1**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTORS:	**David A. Selby**	Confirmation No. **1932**
APPLICATION NO.	**10/806,204**	
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CASE NO.	**RSW9200130089US1**	Group Art Unit: **3623**

TITLE: **SYSTEM, METHOD, AND COMPUTER PROGRAM PRODUCT FOR INCREASING THE EFFECTIVENESS OF CUSTOMER CONTACT STRATEGIES**

FILED ELECTRONICALLY

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

THIRD DECLARATION OF DAVID A. SELBY UNDER 37 C.F.R. §1.131

Sir:

I, David A. Selby, hereby declare as follows:

1. I am the inventor of the subject matter claimed in the above-identified patent application.

2. I have been informed that U.S. Patent Application Publication No. 2005/0010472 to Quatse et al. ("Quatse") has been cited as prior art by the United States Patent and Trademark Office with respect to the above-identified patent application. I also have been informed that the filing date of Quatse is July 8, 2003.

3. This declaration is to establish conception and reduction to practice of the invention claimed in claims 1-24 of the above-identified application in the United States prior to July 8, 2003.

4. Prior to July 8, 2003, I conceived of and developed (i.e., reduced to practice) a working software program that met all of the limitations of claims 1-24 of my patent application, as more particularly detailed below.

5. Exhibit A attached hereto is an Invention Disclosure, prepared by me concerning the development of the invention disclosed and claimed in the above-identified patent application. The date appearing on the original of this document has been redacted from the copy attached hereto. However, the date is prior to July 8, 2003 and accurately reflects a date on which the document existed.

6. Exhibit B attached hereto is a print-out of computer program code for the computer program that is the basis of the present invention ("Vanquish.cpp"). Work on this program began on December 4, 2001 and was completed on or before December 31, 2002, which is prior to the July 8, 2003 filing date of Quatse.

7. Exhibit C attached hereto of a print-out of computer program code for a subroutine ("sidefile.cpp) of Exhibit B. Work on this subroutine was completed on or before December 31, 2002.

8. Exhibit D attached hereto of a print-out of computer program code for a subroutine ("sidefile.h) of Exhibit B. Work on this subroutine was completed on or before December 31, 2002.

9. The correlation between the steps of independent claim 1 and the code in Exhibits B, C, and D is as follows:

- **"performing a first sort on all unselected events to form a pending event list, so that the events are ordered sequentially by their values, with the highest valued event**

being at the top of the pending event list" -- data is pre-sorted in RDBMS engine and pulled into the computation space in the subroutine calls lines 264-295 of Exhibit B. A C++ object is created called "sidefile.cpp" (Exhibit C). This spools the data from the RDBMS engine into a binary flat file on the hard disk local to the program. Once this operation is completed this file is memory mapped into the address space of the program and is referenced as an array from that point forward.

- **"selecting the highest valued unselected event upon the occurrence of a predetermined trigger"** -- this is performed in the subroutine specified in line 356, getnextval. getnextval is found in sidefile.h (Exhibit D), Lines 59-80. The "buckets" referred to is an array of pointers generated by the sidefile generation process, this has divided the population into 4000 pointers, each containing a portion of the value range. Line 60 checks to see if we have completed the run, a sentinel of -1 contains the end point. The end of each pointer set is also marking the end of the range. Line 67 ensures that this value belongs in the value range described by the pointer array, if it is not then it is moved along to the head of the next. This process iterates until we find the next best value or, we have processed all the events.

- **"recomputing the values of each event after the selection of the highest valued unselected event"** -- this is performed in lines 419-436. We apply saturation by updating the saturated value. The saturation values are held in a table (matrix). We allow the user to bias the drop to affected score by using what we term a saturative lever, this is set to 0.5 so we would place the value in the middle. We use the proportion of value between these two as the dampening factor.

- **"moving the highest valued unselected event, after performance of the recomputing step, to the top of the pending event list without performing a second sort of the entire pending event list"** -- this is performed in the subroutine line 356 getnextval by lazy evaluation and is completed in line 447-484 incnextval subroutine. Lazy evaluation

is completed in line 127 of sidefile.h (Exhibit D) where we simply increment the array index.

10. The correlation between the steps of dependent claims 2-8 and the code in Exhibits B, C, and D is as follows:

- **Claim 2. "The method of claim 1, whereby the selecting, recomputing, and moving steps are iteratively performed until the occurrence of a predetermined condition."** -- Line 60 of sidefile.h (Exhibit D) will cause this claim to be met. A fence of negative one is the ending condition in the data.

- **Claim 3. "The method of claim 2, whereby said predetermined condition comprises the selection of a predetermined number of events."** -- Lines 247 – 255 of vanquish.cpp (Exhibit B) retrieve a set of predetermined events .

- **Claim 4. "The method of claim 2, wherein each event has a cost associated with its selection, whereby said predetermined condition comprises the reaching of a predetermined cost total for said selected events."** -- Lines 247 – 255 of vanquish.cpp (Exhibit B) retrieve simultaneously the costs associated with the selection

- **Claim 5. "The method of claim 2, wherein said moving step comprises the performance of a truncated bubble sort with said processor on the events based on their recomputed values."** -- Support for this claim is not found in the code sections attached. The responsibility for performing the bubble sort was transferred to the RDBMS processor, and thus it was not included in this code. The subject matter of this claim, however, was invented and implemented prior to December 31, 2002, but was removed from the code because it was unnecessary.

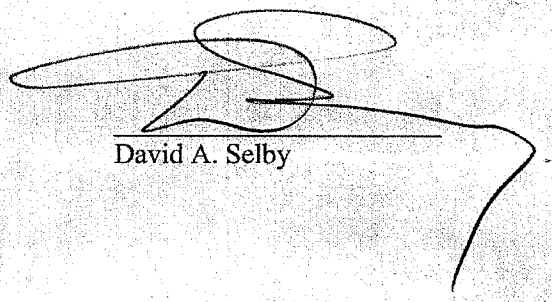
- **Claim 6. "The method of claim 2, wherein said moving step comprises the performance of a binary chop sorting process with said processor on the events based on their recomputed values."** -- Support for this claim is not found in the code sections attached. The bucket technique described above does not require the binary sort, and thus it was not included in this code. The subject matter of this claim, however, was invented and implemented prior to December 31, 2002, but was removed from the code because it was unnecessary.

- **Claim 7. "The method of claim 1, wherein the value of each event comprises each event's expected gain."** --
- >> As per Lines 247 – 255 of vanquish.cpp (Exhibit B), the expected gain is also captured at the same time

- **Claim 8. "The method of claim 7, wherein said recomputing process comprises performing with said processor a saturation process on said unselected events."** -- this is performed in lines 419-436. We apply saturation by updating the saturated value. The saturation values are held in a table (matrix). We allow the user to bias the drop to affected score by using what we term a saturative lever, this is set to 0.5 so we would place the value in the middle. We use the proportion of value between these two as the dampening factor.

11. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issued thereon.

17th Sept 2009
Dated



David A. Selby

EXHIBIT A

Disclosure RSW8-2003-0180

Prepared for and/or by an IBM Attorney - IBM Confidential

Created By David Selby On [redacted] 10:34:18 AM CET
Last Modified By David Selby On [redacted] 06:12:17 AM MST

Required fields are marked with the asterisk (*) and must be filled in to complete the form .

***Title of disclosure (in English)**
A method for optimisation of marketing resources

Summary

Status		Under Evaluation
Final Deadline		
Final Deadline Reason		
*Processing Location		Raleigh - RSW
*Functional Area	select	(GS-Mike Haydoch/BICNS) GS-Mike Haydoch/BICNS
Attorney/Patent Professional		Gregory Doudnikoff/Raleigh/IBM
IDT Team	select	Joel R Grosh/San Diego/IBM
Submitted Date		[redacted] 10:49:24 AM CET
*Owning Division	select	GS
*Line of Business		BCS - Business Consulting Services Primary Inventor's Line of Business (LoB)
*Industry/Sector		Dist - Retail
*Competency		Consulting
Incentive Program		
Lab		
*Technology Code		687C
PVT Score		

Inventors with a Blue Pages entry

Inventors: David Selby/UK/IBM

Inventor Name	Inventor Serial	Div/Dept	Inventor Phone	Manager Name
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Response Due to IP&L	[redacted]

REDACTED

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To: David Selby/UK/IBM@IBMGB
cc: Carl Nicholas Pressley/UK/IBM@IBMGB
Subject: Submission of Disclosure Number RSW820030180
Security: ☒ IBM Confidential
Importance: ○ Urgent ○ Normal

DISCLOSURE NUMBER: RSW820030180
TITLE: A method for optimisation of marketing resources

REDACTED

To: Joel R Grosh/San Diego/IBM
cc: Gregory Doudnikoff/Raleigh/IBM
Subject: Evaluation of Invention Disclosure RSW820030180
Security: ☒ IBM Confidential
Importance: ○ Urgent ○ Normal

DISCLOSURE NUMBER: RSW820030180
TITLE: A method for optimisation of marketing resources

REDACTED

Disclosure: A method for optimisation of marketing resources

Introduction

This disclosure describes a method for solving programmatically the business issue of optimising marketing resources. That is given a set of constraints of marketing materials, customers, budgets etc. An optimal stream of communication is selected which affords the "best" return on investment over time. This over approach has been disclosed in Docket Number P23,426 USA SYSTEM AND METHOD FOR INCREASING THE EFFECTIVENESS OF CUSTOMER CONTACT STRATEGIES

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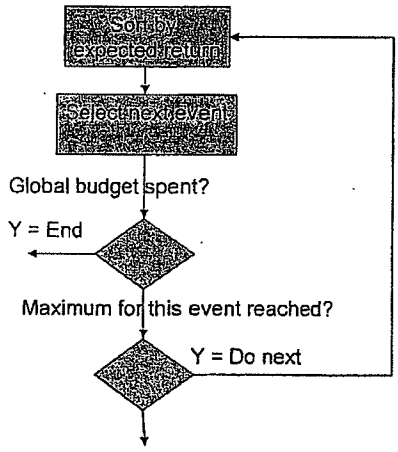
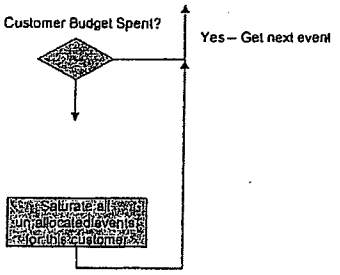
This disclosure makes further claims, by describing a computer-based method, which optimal solves the problem described in the above, by utilising a novel extension to a well-known operational technique called a greedy heuristic. (See www.nist.com for formal definitions)

The method

The objective of the process is to develop a per customer contact stream, that is from the total list of marketing events available to an individual we wish to select a subset which maximises profit for the minimal cost, taking into account a set of business constraints. We propose this can be achieved in the following way:





This approach adopts a well know technique, a greedy heuristic. Although, due to the circumstances involved in the data it is possible to omit the intermediate sort between each application of the saturation. Saturation in nearly all applications reduces the target scores; the knowledge of this allows us to make a simple comparison of the next value to be selected with the subsequent. If this test fails then a sort is required, if this test passes then no sort is required. Omitting this continual sort significantly increases the performance of the technique and allows near real-time application of the approach.

Our Claims

We Claim an approach which:

1. Will solve efficiently enough to enable the solution to be applied to each individual, and therefore improve over the micro groups discussed in the referenced application.
2. By sorting only when required, the algorithm becomes highly scalable.
3. The algorithm achieves a solution that alleviates the need for linear programming.
4. The algorithm can be applied in a real-time application, to recompute the best contact strategy each time the underlying data is changed by customer interaction.

1. Due to the way the problem was being mathematically solved using a linear program in Bibelnieks it was necessary to solve for subsets of customers only on an irregular basis. As it would take large amounts of batch time to solve for a reasonably large portfolio of customers.
    a. The other implication of the Bibelnieks method was that you budget on a per Micro asset group basis. Which can be construed to be a very unrobust approach.

The improvement I have been able to make is to using a greedy Heuristic approach I have been able to solve for each individual customer, and therefore I can budget to an individual customer. Although I would argue the approach I use deviates from the written work enough to be unique, see (2)

2. The GH on its own would not necessarily give you a sufficiently large enough of a kick to allow to solve for an individual, but on examing the typical data used for this type of problem I have discovered a further optimisation.
3. I think Bibelnieks, please verify in case I missed talks about solving the problem once and using for a longish time. My appoach resolves the problem once per day for a constrained time window, say 30-90 days. So it is continually upto date. If you consider before Bibelnieks you would (and most still do) be in a six weeks cycle from generating a list of candidates and the mail dropping. Let alone planning customers, which I think by at least implication would be a long term planning activity.
4. The reason it is desirable to solve it once per day is that you need to be able to dynamically change the customers contact stream as soon as possible. Say it panned out the stream ended up hitting you with campaigns that sold you one particular item, say a winter coat. Well if I do it the Bibelnieks way and run my plan for the next few months, then one week in you buy a winter coat, every campaign you get after that point will be a waste of my marketing budget. Worse it will probably lead you to believe that I'm also stupid because you know we both know that you have a winter coat. So if you can update the plan the day something happens it becomes much more relevant for all subsequent contacts (campaigns). And improves the quality of the ROI from the stream of campaigns.

The GH flow is as follows:

From Bibelnieks you can see an individuals record would consist of a vector of scores for their propensity to respond, with some for of canalization and saturation applied, by a set of matrices. (See Bibelnieks figs 7-11) So you get, each being scored vertically. Normally a set of these would be input to the linear program plus the constraints.

Cannibalization and Saturation are taught by Bibelnieks in Figures 6-11 we would use the same or similar methodology in this approach. Now we deviate, Bibelnieks groups these customers into Micro segments based on some financial return curve for the group. We continue to work at an individual level, and also we operate a per customer budget based on the historical returns, are the ratio of marketing spend vs the amount of net profit for that customer.

Customer No	C1	C2	C3	C4	C5	C6	C7
123456	0.2	0.3	0.565	0.9	0.32	0.53	0.56
123457	0.1	0.8	0.63	0.5	0.21	0.52	0.7

(a) Create a pivot table from the above record, which looks like this:
The important thing to note is the chronological order of the campaigns has not been destroyed. Campaign 1 occurs at T+0 and Campaign 2 occurs at T+1 and Campaign 3 occurs at T+2 etc etc.

Customer No	Campaign	Expected Gain
123456	1	0.2
123456	2	0.3
123456	3	0.565
123456	4	0.9
123456	5	0.32
123456	6	0.53
123456	7	0.56
123457	1	0.1
123457	2	0.8
123457	3	0.63
123457	4	0.5
123457	5	0.21
123457	6	0.52
123457	7	0.7

(b) Sort by expected Gain. (The implication of this step is that you are optimizing the list of contacts globally. (Ie: Independent of any one individual. Any event that creates the best expected gain will be top of the list)

Here a Radix sort is applied, The result is as follows:

⇒

Customer No	Campaign	Expected Gain
123456	4	0.9
123457	2	0.8
123457	7	0.7
123457	3	0.63
123456	3	0.565
123456	7	0.56
123456	6	0.53
123457	6	0.52
123457	4	0.5
123456	5	0.32
123456	2	0.3
123457	5	0.21
123456	1	0.2
123457	1	0.1

(fig 2)

Campaign	C1	C2	C3	C4	C5	C6	C7
Min Piece	1000.00	500.00	1000.00	1000.00	500.00	400.00	800.00
Max Piece	5000.00	1000.00	2000.00	3000.00	1500.00	1200.00	1500.00
Unit Price	0.62	0.56	0.43	1.03	0.93	1.20	1.04
Max Budg	3100.00	560.00	860.00	3090.00	1395.00	1440.00	1560.00
Min Budge	620.00	280.00	430.00	1030.00	465.00	480.00	832.00

(Apologies if this too small, its an imbed so you can blow up) (fig 3)

We entered the optimization procedure with some budgets (or otherwise known as constraints) the table fig 3 above shows for this run the proposed constraints. Number of pieces are decided typically by print run cut offs, that is the printing trade price their work based on economic cut offs, which factor the size of the printing equipment, cost of setup etc. Basically this normally means the more you print the cheaper it gets. In a call centre operation, these cut off's exist but are predicated by the number of operators capable of making outbound email calls, or having the right skill to introduce that type of campaign. (You may have 100 operators but only 10 are specialized in selling mortgage products for instance) For each you have a minimum and a maximum (Upper and lower bound) The cost is the monetary amount it takes to execute each campaign, this yield a maximum budget Pieces times cost. If you add together all of these budget values, then you have the maximum permitted spend for this run of the application. Typically you would want to stay under this

value, the objective is to generate the most return by spending the least. Simple example the goal is to make 100 dollars by spending the least, clearly if I can spend 30 cents and make a 100 its better than spending 50 dollars and making 100. Sure I'm stating the obvious but it's the underlying fundamental in this process. The global budget is set to between (sum min budgets and sum max budgets) This is also helpful because in business the typical thing that happens is that times get tough so every department needs to take say a 10% cut, to meet targets. It's easy to just specify 10% less overall in this process.

(c) Now If the global budget met, we stop. As we allocate a campaign to an individual we sum the number the amount spent. This gives us a comparison number.

(d) We may stop if there nothing that will yield a predicted profit. In the column Expected gain, fig 2 (the arrow moves downward but points to the next entry to consider. If this top entry is negative as we work down the list and continually apply saturation, ie: Once we've done something to an individual subsequent events become less appealing, so we reduce the expected gains.

(e) if we've got nothing left in the pool to allocate, we stop. Max pieces are hit across all events. (fig 3)

(f) Select top record and allocate that customer to that Campaign, before allocating, test if campaign has met budgetary constraint (total pieces or cost budget, you can see they are interchangable) This is done by maintaining counters for each, which are incremented after a successful allocation, also test to see if he's not exceeded this individual's budget. Maintain a counter per individual for their budget. If either is true, then simply discard the record and past to the next, by moving the arrow down one entry in fig 2.

(g) Delete that record from the global list.

(h) Locate that customer in the remaining records and apply saturation to all other campaign records that he has remaining unallocated. This achieved by using a set of indexes to the original data (Fig 1), so although for illustrative purposes Fig 2 has been re-arranged in the actual implementation we would have a vector of indexes. These are sorted and shuffled during the process. See Fig 4. Let's do the first completely. Sort index says take the fourth record as globally the best expected return. The fourth record is Campaign 4 for customer 123456. We set the campaign id to negative, to show it's been used. In Fig 4. We decrement the global count for campaign 4, and we deduct 1.03 from the global budget for customer (See fig 3) Now we apply saturation, which degrades the expected gain for campaigns 1-3 and 5-7. As we know this is the fourth, we step back to the first and iterate over each campaigns expected gain from 1-7 excluding any negative campaign id's. We have now applied the saturative effect of 4 vs 1, 4 vs 2, 4 vs 3, 4 vs 5, etc. Saturative effect is as per Bibelnieks Fig 11. and described in detail, we adopt the same approach for calculating this component. Due to this the expected gain will be reduced for this customer

for all other campaigns proceeding and following the allocated campaign.

Customer Number	Campaign id	Expected Gain
123456	1	0.1
123456	2	0.2
123456	3	0.4
123456	-4	0.9
123456	5	0.2
123456	6	0.53
123456	7	0.52
123457	1	0.1
123457	2	0.8
123457	3	0.63
123457	4	0.5
123457	5	0.21
123457	6	0.52
123457	7	0.7

Sort Index
4
9
14
10
3
7
6
13
11
5
2
12
1
8

Fig 4

(i) Now in a Standard GH you would totally resort the table. We don't. (That's compute intensive, think about it if you have 1m customers over 30 events, that's a 30m record sort, just how it expands...) It turns out that by the nature of saturation, you will suppress all the records remaining by some value, ie: If I give you this campaign it always makes it less likely that things in a near term time horizon will also be given. And we are solving on a say 90 day window, because we can do it that fast.
(j) Ok I've messed my flow a little, but bear with me, I should go to (c) but what I want to do is check the next event is greater that one after the event to be picked, if it isn't I swap the entries, and keep doing that until it is, the technique is similar to that employed in a bubble sort. (Air bubbles rising) Once you know the next is the best you simply continue at (c) Remember this works because you will only make all other events worse, lower value due to the nature of canbalisation/saturisation Look at Fig 5 this is pretty typical, the application of saturation has adjusted some items lower in the list but have had no effect on the next item to choose. (So traditionally you would sort blindly, in this algorithm you take a lazy evaluation approach) This wastes a significant number of computer cycles for no reason.

Customer Number	Campaign id	Expected Gain
123456	1	0.2
123456	2	0.3
123456	3	0.565
123456	4	0.9
123456	5	0.32
123456	6	0.53
123456	7	0.56
123457	1	0.1
123457	2	0.8
123457	3	0.63
123457	4	0.5
123457	5	0.21
123457	6	0.52
123457	7	0.7

Sort Index (Pass 1)	Sort Index (Pass 2)
4	4
9	9
14	14
10	10
3	6
7	7
6	13
13	11
11	3
5	12
2	2
12	5
1	1
8	8

Fig 5

EXHIBIT B

```
1   //
2   // Vanquish optimiser Started: 4 Dec 2001
3   // Author: David Selby
4   //
5   #include <stdio.h>
6   #include <stdlib.h>
7   #include <stdarg.h>
8   #include <time.h>
9   #include <malloc.h>
10  #include <signal.h>
11  #include <iostream.h>
12  #include <string.h>
13  #include <sys/stat.h>
14  #include "parms.h"
15  #include "fileobj.h"
16  #include "sidefile.h"
17  #include "campaigns.h"
18  #include "saturation.h"
19  #include "xmldoc.h"
20
21  #ifndef AIX
22  #define STDIN_FILENO 0
23  #include <io.h>
24  #include <direct.h>
25  #else
26  #define Sleep sleep
27  #endif
28
29  #ifdef DBVER
30  #include "DBobj.h"
31  #endif
32
33  #ifndef TRUE
34  #define TRUE  1
35  #define FALSE 0
36  #endif
37
```

```
38  #ifdef WIN32
39  typedef unsigned __int64 DWORD64;
40  typedef __int64 INT64;
41  #else
42  typedef unsigned long long DWORD64;
43  typedef long long INT64;
44  #endif
45
46  char *make_tname(char *tempdir);
47  static void sig_end(int signo);
48
49  // Various global parameters set by args to main()
50  #ifndef DOS
51  int in_status = 1000;
52  #else
53  int in_status = 100;
54  #endif
55  int out_status = 0;
56  int hush = TRUE;
57  int max_return = 0;
58  int logfile = 0;
59  int db_connect = TRUE;
60  int status_mark = FALSE;
61  char version[] = {"Version 1.0 \0Compile date here"};
62  char *modis;
63  parms *xmlfile;
64
65  int main(int argc,char **argv)
66  {
67  char          foney[]={'-','?'};
68  int           i,j,rtime,assign_count;
69  char          *cp;
70  struct tm     when;
71  time_t        now,starttime,endtime;
72  char          timestamp[15];
73  int           observations = 10000;
74  double total_spent = 0;
```

```
75    unsigned int total_recout = 0;
76
77     #if AIX
78     if (!isatty(STDOUT_FILENO)) in_status = 0; // If piped don't do status msgs
79     #endif
80
81     #ifdef TIMEBOMB
82     int timeBomb(void);
83
84     if (!timeBomb()) { cout << "ABEND: Module expired." << endl << endl;
85                        cout << "Please contact David Selby" << endl << "SELBY at WINVMB" <<
86    "David_Selby@uk.ibm.com" << endl << "Center for Business Optimization" << endl;
87                        cout << "Hursley Park" << endl << "Winchester" << endl << "Hampshire SO21 2JN" << endl
88    << "England" << endl;
89                        exit(-42);
90                      }
91     #endif
92
93     #ifdef MACHONLY
94     int mach(void);
95     if (!mach()) { cout << "ABEND: Machine not licenced to run Vanquish Optimiser" << endl << endl;
96                    exit(-42);
97                  }
98     #endif
99
100    modis = argv[0];
101    strcat(version,__DATE__);
102
103    // Trap various signals
104    signal(SIGINT,  sig_end);
105    signal(SIGTERM, sig_end);
106   #ifdef AIX
107    signal(SIGQUIT, sig_end);
108    signal(SIGIOT,  sig_end);
109    signal(SIGBUS,  sig_end);
110    signal(SIGSEGV, sig_end);
111   #ifdef SIGDANGER
```

```
112     signal(SIGDANGER,sig_end);
113   #endif
114   #endif
115
116   if (argc == 1) { /* Use an underhanded trick to force the help msg */
117                 ++argc; argv[1] = foney;
118               }
119   // Read the command line, Deal with quiet parameter, number of records for internal sort
120   while(--argc > 0) /*&& (*++argv)[0] == '-')*/
121     { ++argv;
122       while(*argv[0] == ' ') (*argv)++;
123       if (*argv[0] == '-')
124         { ++argv[0];
125       if (*argv[0] == '?')
126         { /* Help messages */
127           cout << "Vanquish Optimizer by David Selby" << endl;
128           cout << "Build Date: " << __DATE__ << endl;
129           cout << "Startup Parameters as follows:" << endl;
130           #ifdef DBVER
131           cout << "-noconn Disable connection to Database" << endl;
132           #endif
133           cout << "-quiet Disable all output until first input" << endl;
134           cout << "xxxx  where xxxx is a .xml filename" << endl;
135           exit(0);
136         }
137       /* Quiet switch      */
138       else if (0 == strncmp(argv[0],"quiet",5))
139             { hush = TRUE;
140               // More parms in this token ?
141               if (strlen(argv[0]) > 5) { (*argv) += 5;
142                                          --argv;
143                                          ++argc;
144                                        }
145             }
146       else if (0 == strncmp(argv[0],"noconn",6))
147             { db_connect = FALSE;
148               // More parms in this token ?
```

```
149             if (strlen(argv[0]) > 6) { (*argv) += 6;
150                                        --argv;
151                                        ++argc;
152                                       }
153           }
154       else if (0 == strncmp(argv[0],"status",6))
155           { status_mark = TRUE;
156             in_status = 1000;
157             // More parms in this token ?
158             if (strlen(argv[0]) > 6) { (*argv) += 6;
159                                        --argv;
160                                        ++argc;
161                                       }
162           }
163       else if (0 == strncmp(argv[0],"instat",6) && argc)
164           { if (strlen(argv[0]) > 6) { (*argv) += 6;
165                                        cp = *argv;
166                                       }
167             else { cp = *++argv;
168                    --argc;
169                  }
170             i = strtol(cp,(char **)&cp,10);
171             if (*cp == 'm' || *cp == 'M') i <<= 20;
172             if (*cp == 'k' || *cp == 'K') i <<= 10;
173             if (i >= 0) in_status = i;
174             // More parms in this token ?
175             if (strlen(cp) > 3) { (*argv) = cp;
176                                   --argv;
177                                   ++argc;
178                                 }
179           }
180       else if (0 == strncmp(argv[0],"outstat",7) && argc)
181           { if (strlen(argv[0]) > 7) { (*argv) += 7;
182                                        cp = *argv;
183                                       }
184             else { cp = *++argv;
185                    --argc;
```

```
186                     }
187                 i = strtol(cp,(char **)&cp,10);
188                 if (*cp == 'm' || *cp == 'M') i <<= 20;
189                 if (*cp == 'k' || *cp == 'K') i <<= 10;
190                 if (i >= 0) out_status = i;
191                 // More parms in this token ?
192                 if (strlen(cp) > 3) { (*argv) = cp;
193                                       --argv;
194                                       ++argc;
195                                     }
196               }
197         else if (0 == strncmp(argv[0],"execdir",7) && argc)
198               { if (strlen(argv[0]) > 7) { (*argv) += 7;
199                                            cp = *argv;
200                                          }
201                 else { cp = *++argv;
202                        --argc;
203                      }
204                 if (chdir(cp))
205                    cerr << "unable to change to " << cp << " directory, continuing in current" << endl;
206                 else cerr << "changing to " << cp << endl;
207               }
208           } // ls -... parm
209         else { while(*argv[0] == ' ') ++argv[0]; /* Elide blanks */
210               xmlfile = new parms(argv[0],&max_return);
211               if (max_return)
212                   { if (max_return) printf("Can not find %s",argv[0]);
213                     delete xmlfile;
214                     return -2;
215                   }
216
217           }
218     } /* end while args */
219
220   time( &now );
221   when = *localtime( &now );
222
```

```
223     if (!hush)
224      { cout << "Vanquish Optimizer" << endl << "By David Selby" << endl << "IBM Center for Business
225    Optimization" << endl << "Version 1.4" << endl << "Patents pending" << endl;
226        cout << "Build Date: " << __DATE__ << endl;
227        cout << "Start run at " << asctime( &when ) << endl;
228      }
229
230     /* Timestamp is used as a unique run identifier */
231
232    sprintf(timestamp,"%d%02d%02d%02d%02d%02d\0",1900+when.tm_year,1+when.tm_mon,when.tm_md
233    ay,when.tm_hour,when.tm_min,when.tm_sec);
234
235      //
236      // 1) Open campaigns/events file, need the cost per campaign read into core
237      //
238      dataobject *campaign_data = NULL;
239      campaigns  *campaign_file = NULL;
240    #if DBVER
241      if (xmlfile->campaign_db_name) campaign_data = new DBobj(xmlfile->campaign_db_name, xmlfile-
242    >campaign_db_userid,xmlfile->campaign_db_passwd,xmlfile->campaign_db_table, xmlfile-
243    >campaign_db_where,NULL,xmlfile->campaign_fields,1,xmlfile->campaign_defn);
244
245      else
246    #endif
247      if (xmlfile->campaign_dataFile) campaign_data = new fileobj(xmlfile->campaign_dataFile,xmlfile-
248    >campaign_fields,1,xmlfile->campaign_defn);
249      if (campaign_data) { if (campaign_data->prepare() == 0)
250                           { // Message file failure
251                            // printf(ERR_CAMPAIGN_FILE,xmlfile->campaign_dataFile);
252                             exit(-12);
253                           }
254                         campaign_file = new campaigns(campaign_data);
255                         delete campaign_data;
256                       }
257      else { // Message no campaign data
258           exit(-12);
259         }
```

```
260
261     dataobject *customer_data  = NULL;
262     sidefile   *sidefile_cntrl = NULL;
263     int        ret;
264     // 2) Generate sidefile from customer file, Calculate costs etc. Note zeros and negs
265     //    Do initial bucket pass first time to speed up
266       //
267       // Important!!! The code assumes the customer file contains the data pre sorted by customer
268  number and then within event id.
269       //              Event ids must be assigned in chronological order.  Larger the event id, larger the drop
270  date of the event
271       //
272  #if DBVER
273    if (xmlfile->datafile_db_name) customer_data = new DBobj(xmlfile->datafile_db_name, xmlfile-
274  >datafile_db_userid,xmlfile->datafile_db_passwd,xmlfile->datafile_db_table, xmlfile-
275  >datafile_db_where,xmlfile->datafile_db_order,xmlfile->datafile_fields,1,xmlfile->datafile_defn);
276    else
277  #endif
278    if (xmlfile->datafile_dataFile) customer_data = new fileobj(xmlfile->datafile_dataFile,xmlfile-
279  >datafile_fields,1,xmlfile->datafile_defn);
280
281    if (customer_data) { if (customer_data->prepare() == 0)
282                         { // Message file failure
283                           exit(-14);
284                         }
285                       try { sidefile_cntrl = new sidefile(xmlfile->workpath,&ret,customer_data,campaign_file);
286                         }
287                       catch(int ret)
288                          { cerr << "Internal Sidefile creation failed return code is " << ret << endl;
289                            exit(-144);
290                          }
291                       delete customer_data;
292                     }
293     else { // Message no customer data
294          exit(-14);
295        }
296
```

```
297     // 3) Generate the sort pointer vector (paged) Burn temporary array (3 passes)
298     // 4) Read the saturation matrix into core.
299     dataobject *sat_data = NULL;
300     saturation *sat_file = NULL;
301   #if DBVER
302     if (xmlfile->sat_db_name) sat_data = new DBobj(xmlfile->sat_db_name, xmlfile->sat_db_userid,xmlfile-
303   >sat_db_passwd,xmlfile->sat_db_table, xmlfile->sat_db_where,NULL,xmlfile->sat_fields,1,xmlfile-
304   >sat_defn);
305     else
306   #endif
307     if (xmlfile->sat_dataFile) sat_data = new fileobj(xmlfile->sat_dataFile,xmlfile->sat_fields,1,xmlfile-
308   >sat_defn);
309
310     if (sat_data) { if (sat_data->prepare() == 0)
311                     { // Message file to open saturation file
312                       exit(-15);
313                     }
314                   sat_file = new saturation(sat_data,campaign_file->number,campaign_file->camp_nos);
315                   delete sat_data;
316                 }
317     else { // Message no saturation data
318          exit(-15);
319        }
320
321        //
322        // Need to handle overrides late otherwise the customer data gets messed up.
323        // (You end up zapping the list of numbers, before they used to make the indexes)
324        campaign_file->do_overrides(xmlfile->campaign_override);
325
326     xmlfile->changestate(1); // Project in pending state
327     // 5) Start full process
328     // sat_file->dump(); // Dump saturation matrix for debugging purposes
329     // sidefile_cntrl->debug(); // Dump sidefile for debugging purposes.
330     // FILE *fgraph = fopen("fgraph.csv","w+"); // Debug
331     observations = sidefile_cntrl->no_records() / 100; // 100 bins
332     if (!hush) cout << "Commencing optimization process" << endl;
333     int   obs = 0;
```

```
334      float  spent_graph[100],gain_y[100];
335      gain_y[0] = -1;
336
337      INT64   balance,total,last_balance,balance_pre_min,balance_post_min;
338         DWORD64 gain = 0,gain_net = 0,last_gain = 0;
339
340      if (xmlfile->budget_type == 'n') balance = (INT64)(campaign_file->min_budget +
341   (DWORD64)((double)(INT64)campaign_file->min_budget * ((double)(INT64)xmlfile-
342   >budget/(double)100))); // min +/-x%
343      else if (xmlfile->budget_type == 'x') balance = (INT64)(campaign_file->max_budget -
344   (DWORD64)((double)(INT64)campaign_file->max_budget * ((double)(INT64)xmlfile-
345   >budget/(double)100))); // max +/-x%
346      else balance = (INT64)(100 * xmlfile->budget);
347
348      balance_pre_min = campaign_file->min_budget;    // Spend is allocated from two discrete buckets to
349   handle minima constraint
350      balance_post_min = balance - balance_pre_min;
351         starttime = time(NULL);
352
353      total = balance;
354      dataobject *out_data = NULL;
355      if (balance >= (INT64)campaign_file->min_budget)
356        { while(balance > 0 && sidefile_cntrl->getnextval()) // Fetch next best thing to do
357              { int campno = sidefile_cntrl->catno();
358                int campnox = campno-1;
359                unsigned int cost = campaign_file->costs[campnox];
360                unsigned int fcost = 0;
361                // Handle excluded campaigns
362                if (campaign_file->camp_nos[campnox] == -1) campno = -1;
363                // Handle any fixed costs, first allocation forces one time cost
364                if (campno > 0 && campaign_file->pieces[campnox] == 0) fcost = campaign_file-
365   >fcosts[campnox];
366                //
367                // Handle minimum limit constraint, check which money bucket and ensure has funds to
368   support allocation
369                // Otherwise forefeit the allocation
370                //
```

```
371             if (campno > 0 && (!((campaign_file->min_limit[campnox] && (balance_post_min-cost) >= 0) ||
372                                 (campaign_file->min_limit[campnox] == '\0' && (balance_pre_min-cost+fcost) >=
373 0))))
374                                                         campno = -1;
375             //debug: */
376 fprintf(stderr,"campno=%d,balance=%f,satvalue=%f,count=%d,next_choose=%d,current=%d\n",campno,
377 balance,sidefile_cntrl->get_sat_value(),sidefile_cntrl->Count,sidefile_cntrl->next_choose,sidefile_cntrl-
378 >current);
379             // Start with a sanity check to ensure not selecting a selected campaign
380             // Does this exceed the max pieces for this campaign?
381             if (campno > 0 && (campaign_file->max_pieces[campnox] > campaign_file->pieces[campnox]))
382               { //
383                 // Now handle costs
384                 //
385                 // If this is the first allocation then get any fix costs data
386                 // Check to see if this will exceed the global spend
387                 // if yes then pass and try for something cheaper
388                             unsigned int tcost = cost;
389                             if (campaign_file->pieces[campnox] == 0) tcost = fcost+ cost; // First iteration
390 requires inclusion of fixed cost
391
392                 if ((balance-tcost) >= 0 &&
393                 // Has the individual reached max budget?
394                   (sidefile_cntrl->getcustbudget() == -1 ||    // -1 = no individual budget
395                   (sidefile_cntrl->getcustbudget()-cost) > 0))  // Don't count fixed costs against the individual
396                   { // Allocate campaign to individual
397                                 DWORD64 g;
398                   sidefile_cntrl->allocated_catno();          // Set as allocated
399                   balance -= tcost;                           // Reduce the global balance for this event, incl fixed
400 see above
401                                 g = (DWORD64)floor(0.5 + 100 * sidefile_cntrl->get_sat_value()); //
402 Incorporate gain (Move decimal pt & round)
403                   gain += g;
404                                 g -= tcost;
405                                 gain_net += (DWORD64)g;                 // less costs incl fixed cost
406                   campaign_file->gain[campnox] += (unsigned int)g;   // event gain is also incremented
407                   ++campaign_file->pieces[campnox];           // Increase number used
```

```
408                     if (!campaign_file->min_limit[campnox])     // Have we reached the min constraint?
409                       { balance_pre_min -= cost + fcost;
410                         if (campaign_file->min_pieces[campnox] == campaign_file->pieces[campnox])
411                               campaign_file->min_limit[campnox] = '\1';
412                       }
413                     else balance_post_min -= cost;
414
415                     // If running with individual budget then reduce also
416                     if (sidefile_cntrl->getcustbudget() != -1) sidefile_cntrl->set_custbudget((float)cost/100);
417
418                     //
419                     // Now saturate across all campaigns
420                     // sidefile has not changed order so just need to back up
421                     sidefile_cntrl->select_first();
422                                     assign_count = 0;
423                     for(int i = 0; i < campaign_file->number; i++)
424                       { if (sidefile_cntrl->catno() > 0 && sidefile_cntrl->get_sat_value() > 0)  // If its already
425 negative then don't waste mips
426                                                 {  float unsat = sidefile_cntrl->get_unsat_value() /
427 ((float)campaign_file->costs[i]/100); // Correct to gains ratio
428                                                     // sidefile_cntrl->set_sat_value(sidefile_cntrl-
429 >get_sat_value() - ((float)xmlfile->sat_lever * (sidefile_cntrl->get_unsat_value() * sat_file-
430 >satmat[i][campnox] + sat_file->satmat[campnox][i] * sidefile_cntrl->get_unsat_value())));
431                                                   sidefile_cntrl->set_sat_value(sidefile_cntrl->get_sat_value()
432 - ((float)xmlfile->sat_lever * (unsat * sat_file->satmat[i][campnox] + sat_file->satmat[campnox][i] * unsat)));
433                                                 }
434                                       if (sidefile_cntrl->catno() < 0) ++assign_count;
435                         if (sidefile_cntrl->getnext_srt()) break;
436                       }
437                                     // If we have hit the limit of events for this customer then saturate all
438 remaining available events
439                                     // Just force it out with a large loss
440                                     if (xmlfile->maxoffersper && xmlfile->maxoffersper == assign_count)
441                                     { sidefile_cntrl->select_first();
442                                       for(int i = 0; i < campaign_file->number; i++)  if (sidefile_cntrl->catno() >
443 0 && sidefile_cntrl->get_sat_value() > 0) sidefile_cntrl->set_sat_value((float)-999999999);
444                                     }
```

```
445                     }
446                   }
447               sidefile_cntrl->incnextval(); // Move to next entry
448               // Output a diagnostic to help understand progress
449               if (in_status && ((sidefile_cntrl->getnextone() % in_status) == 0))
450                 { /*char msg[50];
451                   sprintf(msg,"Reading record %ld        ",sidefile_cntrl->getnextone());
452                   cout << msg;
453                   int i = strlen(msg);
454                   while(i--) cout << "\b";
455                   cout << flush;
456                   */
457                                 endtime = time(NULL);
458                                 rtime = (int)(double)ceil((double)(sidefile_cntrl->no_records()-sidefile_cntrl-
459 >getnextone()) * (endtime-starttime)/((sidefile_cntrl->getnextone() == 0)?1:sidefile_cntrl->getnextone()));
460                                 tm *t = gmtime((time_t *)&rtime);
461                                 int ts = t->tm_sec;
462                                 if (t->tm_hour == 0 && t->tm_min == 0 && ts == 0) ts = 1;
463
464                                 cout << "#" << sidefile_cntrl->getnextone() << "," << sidefile_cntrl->no_records()
465 << "," << t->tm_hour << ':' << t->tm_min << ':' << ts << endl << flush;
466                                 cout.flush();
467                                 cout.flush();
468                                 Sleep(1);
469               }
470             // Generate a file for the gains graph
471             if (0 == --observations)
472               { observations = sidefile_cntrl->no_records() / 100; // 100 bins
473                 if (last_gain != 0 && last_gain != gain_net)
474                   { float gr = (float)((double)(INT64)(gain_net-last_gain)/(double)(INT64)((total-balance)-
475 last_balance));
476                     spent_graph[obs] = (float)(total-balance);
477                     gain_y[obs] = gr;
478                     gain_y[++obs] = -1;  // Use -1 as fence to mark end
479                     // fprintf(fgraph,"%f,%f\n",total-balance,gr);
480                   }
481               last_balance = total-balance;
```

```
482                     last_gain = gain_net;
483                   }
484               }
485                 // Mop up residuals
486               if (last_gain != gain_net && (observations != (int)(sidefile_cntrl->no_records() / 100)))
487                 { float gr = (float)((double)(INT64)(gain_net-last_gain)/(double)(INT64)((total-balance)-
488  last_balance));
489                   spent_graph[obs] = (float)(INT64)(total-balance);
490                   gain_y[obs] = gr;
491                   gain_y[++obs] = -1;
492                     //fprintf(fgraph,"%f,%f\n",total-balance,gr);
493                 }
494              //fclose(fgraph);
495           //
496           // Output statistics from the run
497           //
498           cout << flush;
499                 cout << "#" << sidefile_cntrl->no_records() << "/" << sidefile_cntrl->no_records() << ",0:0:0" <<
500  endl << flush << flush;
501
502                 if (xmlfile->xmlstats)
503           {  cout << "Optimization processing completed" << endl;
504           cout << "<<< Global Statistics from run >>>" << endl;
505           int i;
506           for(i = 0; i < campaign_file->number; i++)
507             { if (campaign_file->camp_nos[i] > 0)
508                 {  if (campaign_file->pieces[i] < campaign_file->min_pieces[i]) cout << "*";
509                     cout << "Campaign " << campaign_file->camp_nos[i] << " Allocated " << campaign_file-
510  >pieces[i] << " min=" << campaign_file->min_pieces[i] << " max=" << campaign_file->max_pieces[i] << "
511  pieces" << endl;
512                     total_spent += campaign_file->pieces[i] * campaign_file->costs[i];
513                     total_recout += campaign_file->pieces[i];
514                 }
515             }
516          cout << "Overall cost incurred " << ((double)(INT64)total_spent/100) << " against a budget of " <<
517  ((double)(INT64)total/100) << " balance is " << ((double)(INT64)balance/100) << endl;
```

```
518         cout << "Estimated gross gain is " << ((double)(INT64)gain/100) << " Net gain is " <<
519 ((double)(INT64)gain_net/100) << endl;
520         cout << "Estimated profit margin is " << 100 * ((double)(INT64)gain_net/(double)(INT64)gain) <<
521 "%" << endl;
522
523
524                 xmldoc *statsdoc = new xmldoc("stats"); // Create document
525           if (statsdoc)
526             { char numbuf[60];
527               sprintf(numbuf,"%.2f",((float)(INT64)total)/100);
528               statsdoc->clog_off = TRUE;
529               statsdoc->chg("\\stats\\description",xmlfile->description);
530               statsdoc->add("\\stats\\runid",timestamp);
531               statsdoc->add("\\stats\\projectid",xmlfile->projectid);
532               statsdoc->add("\\stats\\budget",numbuf);
533               sprintf(numbuf,"%.2f",((float)(INT64)balance)/100);
534               statsdoc->add("\\stats\\balance",numbuf);
535
536               // Store Gains graph
537               i = 0;
538               char *buf = new char[sizeof("\\stats\\gaingraph@pnt=1000")];
539               do { sprintf(numbuf,"%.2f,%.2f",spent_graph[i]/100.0,gain_y[i]);
540                  sprintf(buf,"\\stats\\gaingraph@pnt=%d",i+1);
541                  statsdoc->add(buf,numbuf);
542               } while(gain_y[++i] != -1);
543
544                       sprintf(buf,"\\stats\\graph@pnts=%d",i+1);
545                       statsdoc->add(buf,NULL);
546
547               delete [] buf;
548
549               for(i = 0, j = 1; i < campaign_file->number; i++)
550                 { if (campaign_file->camp_nos[i] > 0)
551                     { char ev[sizeof("\\stats\\event@id=9999\\description")+3];
552                       sprintf(numbuf,"%d",j);   //DAS -- Caryn can't take zero origin output
553                       statsdoc->add("\\stats\\event@id",numbuf);
554                       sprintf(ev,"\\stats\\event@id=%d\\eventid",j);
```

```
555                 sprintf(numbuf,"%d",campaign_file->camp_nos[i]);
556                 statsdoc->add(ev,numbuf);
557                 sprintf(ev,"\\stats\\event@id=%d\\description",j);
558                 statsdoc->add(ev,campaign_file->desc[i]);
559                 sprintf(ev,"\\stats\\event@id=%d\\minpieces",j);
560                 sprintf(numbuf,"%d",campaign_file->min_pieces[i]);
561                 statsdoc->add(ev,numbuf);
562                 sprintf(ev,"\\stats\\event@id=%d\\maxpieces",j);
563                 sprintf(numbuf,"%d",campaign_file->max_pieces[i]);
564                 statsdoc->add(ev,numbuf);
565                 sprintf(ev,"\\stats\\event@id=%d\\allocated",j);
566                 sprintf(numbuf,"%d",campaign_file->pieces[i]);
567                 statsdoc->add(ev,numbuf);
568                 sprintf(ev,"\\stats\\event@id=%d\\fcost",j);
569                 sprintf(numbuf,"%.2f",(float)campaign_file->fcosts[i]/100);
570                 statsdoc->add(ev,numbuf);
571                 sprintf(ev,"\\stats\\event@id=%d\\cost",j);
572                 sprintf(numbuf,"%.2f",(float)campaign_file->costs[i]/100);
573                 statsdoc->add(ev,numbuf);
574                 sprintf(ev,"\\stats\\event@id=%d\\gain",j++);
575                 sprintf(numbuf,"%.2f",(float)campaign_file->gain[i]/100);
576                 statsdoc->add(ev,numbuf);
577               }
578             }
579           sprintf(numbuf,"%d",j-1);
580           statsdoc->add("\\stats\\events@no",numbuf);
581           char *s = new char[sizeof("stats.xml")+1];
582           strcpy(s,"stats.xml");
583           statsdoc->setfilename(s);
584           statsdoc->flush();
585           statsdoc->clog_off = FALSE;
586           delete statsdoc;
587       }
588         }
589             else { sidefile_cntrl->restart();
590                 int total_contacts = 0;
591                 while(sidefile_cntrl->next_custno()) // for each customer input
```

```
592                         { int contact = 0;
593                             do { if (sidefile_cntrl->catno() < 0) contact = 1; } while(!sidefile_cntrl-
594  >getnext_srt());
595                             total_contacts += contact;
596                 }
597                         cout << "##{\"budget\" : \"" << ((float)(INT64)total/100.0) << "\",\"balance\" : \"" <<
598  ((float)(INT64)balance/100) << "\",\"obs\" : \"" << obs << "\",\"events\" : \"" << campaign_file->number <<
599  "\",\"contacts\" : \"" << total_contacts << "\",\"customers\" : \"" << sidefile_cntrl->total_customers << "\"}";
600                         for(i = 0; i < obs; i++) cout << ",{\"point\" : \"" << spent_graph[i]/100.0 << "," <<
601  gain_y[i] << "\"}";
602                 for(i = 0; i < campaign_file->number; i++)
603                         if (campaign_file->camp_nos[i] > 0)
604                         { cout << ",{\"event\" : \"" << campaign_file->camp_nos[i] << "\",\"desc\" : \"" <<
605  campaign_file->desc[i] << "\",\"mediacode\" : \"" << campaign_file->mediacde[i] << "\"";
606                     cout << ",\"minpieces\" : \"" << campaign_file->min_pieces[i] << "\",\"maxpieces\" : \"" <<
607  campaign_file->max_pieces[i] << "\",\"allocated\" : \"" << campaign_file->pieces[i] << "\",\"fcost\" : \"" <<
608  campaign_file->fcosts[i] << "\",\"cost\" : \"" << campaign_file->costs[i] << "\",\"gain\" : \"" << campaign_file-
609  >gain[i] << "\"}";
610                                 total_spent += campaign_file->pieces[i] * campaign_file->costs[i];
611                     total_recout += campaign_file->pieces[i];
612                   }
613                 cout << endl;
614         //          cout << "]\n" << endl;
615                         }
616  #if DBVER
617             // Write stats to database if required
618             if (xmlfile->runstats_db_name)
619               { // Additionally insert into a couple of database tables
620                 out_data = new DBobj(xmlfile->runstats_db_name,xmlfile->runstats_db_userid, xmlfile-
621  >runstats_db_passwd,xmlfile->runstats_db_table1, NULL,NULL,xmlfile->runstats_fields1,2,xmlfile-
622  >runstats_defn);
623               if (out_data) { out_data->setbuffer(1);
624                         if (out_data->prepare())
625                           { out_data->setrecs(1);
626                             field *f = xmlfile->runstats_fields1;
627                             out_data->setString("runid",timestamp);
628                             if (xmlfile->description) out_data->setString("description",xmlfile->description);
```

```
629                         out_data->setString("projectid",xmlfile->projectid);
630                         out_data->setFloat("budget",(float)(INT64)total/100);
631                         out_data->setFloat("balance",(float)(INT64)balance/100);
632                                                 out_data->setInt("points",obs);
633                                                 out_data->setVect("gaingraphx",spent_graph);
634                                                 out_data->setVect("gaingraphy",gain_y);
635                         out_data->setInt("events",campaign_file->number);
636                         out_data->writenext();
637                         delete out_data;
638                         out_data = new DBobj(xmlfile->runstats_db_name,xmlfile->runstats_db_userid,
639 xmlfile->runstats_db_passwd,xmlfile->runstats_db_table2,NULL,NULL,xmlfile->runstats_fields2,2,xmlfile-
640 >runstats_defn);
641                         if (out_data) { out_data->setbuffer(j);
642                                 if (out_data->prepare())
643                                   { out_data->setrecs(j);
644                                     field *f = xmlfile->runstats_fields2;
645                                     for(i = 0; i < campaign_file->number; i++)
646                                       { if (campaign_file->camp_nos[i] > 0) // Handle overrides
647                                         { out_data->setString("runid",timestamp);
648                                           out_data->setInt("eventid",campaign_file->camp_nos[i]);
649                                           out_data->setString("description",campaign_file->desc[i]);
650                                           out_data->setInt("minpiece",campaign_file->min_pieces[i]);
651                                           out_data->setInt("maxpiece",campaign_file->max_pieces[i]);
652                                           out_data->setInt("alloc",campaign_file->pieces[i]);
653                                           out_data->setFloat("cost",(float)campaign_file->costs[i]/100);
654                                           out_data->setFloat("fcost",(float)campaign_file->fcosts[i]/100);
655                                           out_data->setFloat("gain",(float)campaign_file->gain[i]/100);
656                                           out_data->writenext();
657                                         }
658                                       }
659                                   }
660                                 delete out_data;
661                               }
662                         }
663                 }
664
665         }
```

```
666  #endif
667          // 6) Generate output file
668       #if DBVER
669          if (xmlfile->output_db_name)  out_data = new DBobj(xmlfile->output_db_name, xmlfile-
670  >output_db_userid, xmlfile->output_db_passwd,xmlfile->output_db_table, xmlfile-
671  >output_db_where,NULL,xmlfile->output_fields,2,xmlfile->output_defn);
672          else
673       #endif
674          if (xmlfile->output_dataFile) out_data = new fileobj(xmlfile->output_dataFile,xmlfile-
675  >output_fields,0,xmlfile->output_defn);
676
677          if (out_data) { // Simply run thru the sidefile from top to bottom and output selected campaigns
678                    if (out_data->prepare())
679                     { // Return can happen because of failure or Suppress, complete run anyway.
680                      out_data->setrecs(total_recout);
681                      sidefile_cntrl->restart();
682                      field *f = xmlfile->output_fields;
683                      int bvect = FALSE;
684                      // Check to see if this is the boolean output style
685                      while(f) { if (f->type == 'b' && f->repeat)
686                                 { bvect = TRUE;
687                                   f->val.str = new char[f->repeat*2];
688                                   memset(f->val.str,' ',f->repeat*2);
689                                 }
690                               f = f->next;
691                              }
692
693                      while(sidefile_cntrl->next_custno())  // for each customer input
694                         { //for(int i = 0; i < campaign_file->number; i++)
695                           //  { if (bvect)  // This was the original debug method, output a series of 0 and 1's
696                           //      { out_data->setBoolean("rvect",i,sidefile_cntrl->catno_inc() < 0);
697                           //        if (i == (campaign_file->number-1)) out_data->writenext();
698                           //      }
699                           //   else
700                                                  do { if (sidefile_cntrl->catno() < 0)
701                                 {  // out_data->setString("projectid",xmlfile->projectid);
702                                    // out_data->setString("rundate",timestamp);
```

```
703                                     out_data->setString("custid",sidefile_cntrl->get_custno());
704                                     out_data->setInt("eventid",campaign_file->camp_nos[(-sidefile_cntrl-
705   >catno())-1]);
706                                     if (out_data->writenext()) break;  // Drop out if failure
707                                   }
708                                                         } while(!sidefile_cntrl->getnext_srt());
709                             }
710                         // if (bvect) while(f) { if (f->type == 'b' && f->repeat) delete [] f->val.str;
711                         //                       f = f->next;
712                         //                     }
713                       }
714                   }
715       }
716     else cout << "Error: Minimum cost of campaigns exceeds imposed global budget" << endl;
717
718     xmlfile->add("\\project\\runid",timestamp); // Put the run id into the parms file
719     xmlfile->changestate(2,modis,version,(long)difftime(time(NULL),now)); // Project in completed state
720   (Useful to know runtime for reference)
721
722     delete campaign_file;
723     delete sidefile_cntrl;
724     delete sat_file;
725     delete out_data;
726
727     if (!hush)
728       { time( &now );
729         when = *localtime( &now );
730         cout << "Finish run at " << asctime( &when ) << endl;
731       }
732
733    return 0;
734   }
735
736   static void sig_end(int signo)
737   {
738   struct tm       when;
739   time_t          now;
```

```
740
741         switch(signo) {
742         case SIGINT:  cerr << "Interrupt Signal received" << endl; break;
743         case SIGTERM: cerr << "Terminate Signal received" << endl; break;
744         #ifdef AIX
745         case SIGQUIT: cerr << "Quit Signal received" << endl; break;
746         case SIGIOT:  cerr << "I/O Terminate Signal received" << endl; break;
747         case SIGBUS:  cerr << "Bus error Signal received" << endl; break;
748         case SIGSEGV: cerr << "Segmentation fault Signal received" << endl; break;
749         #ifdef SIGDANGER
750         case SIGDANGER: cerr << "Danger Signal received, machine low on resource" << endl; break;
751         #endif
752         #endif
753         default: cerr << "Unknown signal caught no=%d" << signo << endl;
754                 }
755
756         cout << endl << "ERROR: Forced run abort" << endl;
757         time( &now );
758         when = *localtime( &now );
759         cout << "Finish run at " << asctime( &when ) << endl;
760
761         delete xmlfile;
762         exit(-16708);
763   }
764
765   char *make_tname(char *tempdir)
766   {
767   struct stat  stbuf;
768   char        temp_name[] = {"VQtmp000"};
769   char       *tempfile = temp_name;
770   int         name_cnt = 1,handle = -1,append;
771
772    // Sort out temporary directory name
773    if (tempdir) { // Do we need to append a / or \ ?
774                 append = strlen(tempdir);
775                 if (tempdir[append-1] == '/' || tempdir[append-1] == '\\') append = 1;
776                 else append  = 2;
```

```
777             }
778     tempfile = (tempdir) ? new char[append+strlen(tempdir)+strlen(temp_name)] :
779                     new char[1+strlen(temp_name)];
780     // Locate a free slot
781     while(handle == -1 && name_cnt < 999)
782        { if (tempdir) { strcpy(tempfile,tempdir);
783                     #ifdef AIX
784                     if (append == 2) strcat(tempfile,"/");
785                     #else
786                     if (append == 2) strcat(tempfile,"\\");
787                     #endif
788                     strcat(tempfile,temp_name);
789                    }
790          else strcpy(tempfile,temp_name);
791          handle = stat(tempfile, &stbuf);
792          if (handle == -1) break;
793          else { if (temp_name[7] == '9')
794                 { temp_name[7] = '0';
795                   if (temp_name[6] == '9')
796                     { temp_name[6] = '0';
797                       if (temp_name[5] == '9') temp_name[5] = '0';
798                       else ++temp_name[5];
799                     }
800                   else ++temp_name[6];
801                 }
802               else ++temp_name[7];
803              }
804          ++name_cnt; handle = -1;
805        }
806
807   if (name_cnt == 999) { cerr << "Error: Cannot find free temporary name\nPlease delete FStmpnnn files"
808 << endl;
809                     return NULL;
810                    }
811 return tempfile;
812 }
813
```

```
814   #ifdef TIMEBOMB
815   int timeBomb(void)
816   {
817      time_t      endtime ;        /* time of expiry              */
818      struct tm   endtm   ;        /* time of expiry structure    */
819      endtm.tm_sec = 0;
820      endtm.tm_min = 0;
821      endtm.tm_hour = 0;
822      endtm.tm_mday =01;           /* date at which it first becomes invalid*/
823      endtm.tm_mon = 10;           /* note - zero origin, Jan = 0    !!! */
824      endtm.tm_year = 99;          /* about six months hence          */
825      endtm.tm_wday = 0;
826      endtm.tm_yday = 0;
827      endtm.tm_isdst = 0;
828      return (int)(time(NULL) < mktime(&endtm));
829   } /* end timeBomb */
830   #endif
831
832   #ifdef MACHONLY
833   int mach(void)
834   {                          /* Test to see if on specified network */
835      FILE        *machchk;
836      char        c;
837
838      machchk = popen("hostname | xargs host | grep -c ' 10.'", "r");
839      fread(&c, 1, 1, machchk);  /* get results of command      */
840      pclose(machchk);           /* Close pipe                  */
841
842      return (int) (c != '0');   /* 1 =OK 0= non licenced network    */
843   }
844   #endif
845
846   char *timemod(char *time)
847   {
848   static char buf[30];
849
850      strcpy(buf,time);
```

```
851         char *t = strchr(buf,'\n');
852         if (t) *t = '\0';
853
854       return buf;
855     }
856
857
```

EXHIBIT C

```
1   #include "campaigns.h"
2   #include "sidefile.h"
3   #include "dataobject.h"
4   #include <fcntl.h>
5   #include <iostream.h>
6   #include <time.h>
7
8   char *make_tname(char *path);
9   char *timemod(char *t);
10  extern int hush;
11
12  //
13  // Generate two sidefiles to aid scalability and performance
14  //
15  // File 1, primary compute file contains promotion/saturated cost
16  // File 2, contains customer key
17  // File 3, contains customer budget
18  //
19
20  sidefile::sidefile(char *sfpath,int *maxret,dataobject *customers,campaigns *camps)
21  {
22  int         newcustomer;
23  unsigned int  i;
24  struct tm     when;
25  time_t        now;
26  unsigned int  *costs = camps->costs;
27  double        sumx,sumx2;
28
29    // Create the sidefiles
30    tempname1 = make_tname(sfpath);
31    fhandle1 = open(tempname1, O_EXCL | O_CREAT | O_RDWR | O_BINARY, 0666);
32    if (fhandle1 == -1) { // errmsg(ERR_FAILED_OPEN,sfname);
33                          throw (int)-1;
34                        }
35    tempname2 = make_tname(sfpath);
36    fhandle2 = open(tempname2, O_EXCL | O_CREAT | O_RDWR | O_BINARY, 0666);
37    if (fhandle2 == -1) { // errmsg(ERR_FAILED_OPEN,sfname);
38                          throw (int)-1;
39                        }
40
41    tempname3 = make_tname(sfpath);
42    fhandle3 = open(tempname3, O_EXCL | O_CREAT | O_RDWR | O_BINARY, 0666);
43    if (fhandle3 == -1) { // errmsg(ERR_FAILED_OPEN,sfname);
44                          throw (int)-1;
45                        }
46
47    // How many promotions are there in this run?
48    // input file has to contain customer no,budget,expected gains (propensity * estimated gain)
49    // Should be customer no,budget,promo_no,expected gain. Per record
50    //
51
```

```
52      // Prime customer number
53      int  custno_length = customers->getLength("custid");
54      custrec = (custdata *)malloc(custno_size = custno_length+1);
55      --custno_size;
56      memset(&custrec->cust_no,0,custno_length);
57      rec_size2 = custno_length;              // Customer number
58      zero_cnt = 0;
59      neg_cnt = 0;
60      max_value = 0;
61      has_budgets = FALSE;
62      no_campaigns = 0;
63      sumx = sumx2 = 0;
64      Count = 0;
65      total_customers = 0;
66
67      time( &now );
68      when = *localtime( &now );
69      if (!hush) cout << "<<< Locating events under consideration; started at " << timemod(asctime( &when
70    )) << " >>>" << endl;
71      while(customers->readnext())
72          { // Check to see if this campaign is in the list
73           if (camps->isMember(customers->getInt("eventid")))
74             { // Budget file gets written once per customer
75              if (0 != strcmp(&custrec->cust_no,customers->getString("custid")))
76                 { // Change of customer write next record
77                  strcpy(&custrec->cust_no,customers->getString("custid"));
78                                 newcustomer = TRUE;
79                                 ++total_customers;
80                  float budget = customers->getFloat("budget");
81                  if (budget != 0.0) has_budgets = TRUE;
82                  if (sizeof(float) != ::write(fhandle2,&budget,sizeof(float)))
83                    { // Message file system full?
84                     throw (int)-2;
85                    }
86
87                  if (rec_size2 != ::write(fhandle3,custrec,rec_size2))
88                    { // Message file system full?
89                     throw (int)-3;
90                    }
91                 }
92                      else newcustomer = FALSE;
93
94              _catno = 1+camps->getIndex(customers->getInt("eventid"));
95                      if (newcustomer) _catno |= CUSTOMER_FENCE;
96
97              _unsat_value = customers->getFloat("resval");
98
99              // Starting position removes the cost of campaign
100             if (costs[_catno-1] > 0) _sat_value = _unsat_value - ((float)costs[_catno-1]/100);
101             else _sat_value = 0;
102
```

```
103             if (_sat_value == 0) ++zero_cnt;
104             if (_sat_value < 0)  ++neg_cnt;
105             else { if (max_value < _sat_value) max_value = _sat_value;
106                         sumx += _sat_value;
107                             sumx2 += _sat_value * _sat_value;
108                             }
109
110
111             // Spool out the main file system
112             if (record_size != ::write(fhandle1,&_catno,record_size))
113               { // Message file system full?
114                 throw (int)-4;
115               }
116
117           ++Count;
118           } // event not in list
119         } // While not eof
120
121     #ifdef WIN32
122       close(fhandle1);
123
124       fh = CreateFile( tempname1, GENERIC_READ |
125     GENERIC_WRITE,0,NULL,OPEN_EXISTING,FILE_ATTRIBUTE_NORMAL,NULL);
126       if ((int)fh == -1) { int dwErr = GetLastError();
127                     cout << "Error: Failed to create mapped file reason=" << dwErr << endl;
128                     throw -5;
129                   }
130       DWORD size =  GetFileSize ((HANDLE)fh, NULL);
131       Maphand =
132     CreateFileMapping(fh,NULL,(DWORD)PAGE_READWRITE,0,size,(LPCTSTR)"maindata");
133       if (Maphand != NULL) data = (char *)MapViewOfFile(Maphand,FILE_MAP_WRITE,0,0,0);
134       else  { int dwErr = GetLastError();
135           cout << "Error: Failed to create mapping of file " << tempname1 << " reason=" << dwErr << endl;
136           throw -6;
137         }
138
139       close(fhandle2);
140       if (has_budgets)
141         {
142           fh1 = CreateFile( tempname2, GENERIC_READ |
143     GENERIC_WRITE,0,NULL,OPEN_EXISTING,FILE_ATTRIBUTE_NORMAL,NULL);
144           if ((int)fh1 == -1) { int dwErr = GetLastError();
145                         cout << "Error: Failed to create mapped file reason=" << dwErr << endl;
146                         throw -4;
147                       }
148           size =  GetFileSize ((HANDLE)fh1, NULL);
149           Maphand1 =
150     CreateFileMapping(fh1,NULL,(DWORD)PAGE_READWRITE,0,size,(LPCTSTR)"budgets");
151           if (Maphand1 != NULL) budgets = (float *)MapViewOfFile(Maphand1,FILE_MAP_WRITE,0,0,0);
152           else  { int dwErr = GetLastError();
```

```
153             cout << "Error: Failed to create mapping of file " << tempname2 << " reason=" << dwErr <<
154 endl;
155             throw -5;
156           }
157     }
158 #else // UNIX platforms (This needs checking!!)
159     size = ::lseek64(fhandle1,0,SEEK_END);
160     ::lseek(fhandle1,0,SEEK_SET);
161   //  printf("Here file size = %d\n",size);
162     data = (char *)mmap(NULL,size,PROT_WRITE |
163 PROT_READ,MAP_PRIVATE|MAP_FILE,fhandle1,0);
164   //  printf("addr=%u,errno=%d\n",data,errno);
165     budsize = ::lseek64(fhandle2,0,SEEK_END);
166     ::lseek(fhandle2,0,SEEK_SET);
167  //   printf("Here file size = %d\n",budsize);
168     budgets = (float *)mmap(NULL,size,PROT_WRITE |
169 PROT_READ,MAP_PRIVATE|MAP_FILE,fhandle2,0);
170  //   printf("addr=%u,errno=%d\n",budgets,errno);
171 #endif
172
173     sfptr = (sfentry *)data; // Point at memory mapped file
174       current = 0;
175
176       // Fiddle with the max_value to be 2 std deviation from the mean or 95%
177       // This gives the bucketing a nice even distribution
178       { double  mean = sumx  / Count;
179      double  sig  = sumx2 / Count;
180      double  sd = sqrt(sig - (mean * mean));
181      max_value = (float)min(max_value, mean + 2 * sd);
182       }
183
184     // Allocate bucket space
185     buckets = new unsigned int[NO_BUCKETS];
186     memset(buckets,0xff,sizeof(unsigned int) * NO_BUCKETS); // Initialise -1 = no data.
187
188     // Allocate an array for all the records
189     datavect = new unsigned int[Count];
190     memset(datavect,0xff,sizeof(unsigned int)*Count);   // Set chains to -1 no data
191
192    // We know the maximum value normalise into the buckets.
193     for(i = 0; i < Count; i++)
194     { // Locate a bucket chain to put this value on
195      int index = get_bucket_index(sfptr[current].sat_val);
196      datavect[current] = buckets[index];
197      buckets[index] = current++;
198     }
199
200     // Ok ready to start allocating events, now...
201     time( &now );
202     when = *localtime( &now );
```

```
203     if (!hush) cout << "<<< Completed at " << timemod(asctime( &when )) << " " << Count << " events
204 under consideration >>>" << endl;
205     current_bucket = NO_BUCKETS-1; // Start in the highest valued bin
206       next_choose = 0;
207 }
208
209 void sidefile::debug()
210 {
211  for(unsigned int i = 0; i < Count; i++)
212     fprintf(stderr,"catno=%d,unsat=%f,sat=%f\n",sfptr[i].eventno,sfptr[i].unsat_val,sfptr[i].sat_val);
213
214 #ifdef WIN32
215  flushall();
216 #endif
217 }
218
219 sidefile::~sidefile()
220 {
221  if (fhandle1 > 0) {
222 #ifdef WIN32
223                 if (!UnmapViewOfFile(data)) cout << "Error: Failed to unmap" << endl;
224                 if (!CloseHandle(fh))       cout << "Error: Failed to close file" << endl;
225                 if (!CloseHandle(Maphand))  cout << "Error: Failed to close map handle" << endl;
226 #else             // UNIX
227                 munmap(data,size);
228                 close(fhandle1);
229                 munmap(budgets,budsize);
230                 close(fhandle2);
231 #endif
232                 if (unlink(tempname1) == -1)
233                     cout << "Error: Unable to delete " << tempname1 << " err=" << errno << endl;
234                 delete [] tempname1;
235               }
236
237  if (fhandle2 > 0) {
238 #ifdef WIN32
239                 if (has_budgets)
240                   { if (!UnmapViewOfFile(budgets)) cout <<"Error: Failed to unmap" << endl;
241                     if (!CloseHandle(fh1))         cout <<"Error: Failed to close file" << endl;
242                     if (!CloseHandle(Maphand1))    cout <<"Error: Failed to close map handle" << endl;
243                   }
244 #else             // UNIX
245                 munmap(budgets,size);
246                 close(fhandle2);
247 #endif
248                 if (unlink(tempname2) == -1)
249                     cout << "Error: Unable to delete " << tempname2 << " err=" << errno << endl;
250
251                 delete [] tempname2;
252               }
253
```

```
254     if (fhandle3 > 0) { close(fhandle3);
255                         if (unlink(tempname3) == -1)
256                             cout << "Error: Unable to delete " << tempname3 << " err=" << errno << endl;
257
258                         delete [] tempname3;
259                       }
260     }
```

EXHIBIT D

```
1   #ifndef INCL_SIDEFILE
2   #define INCL_SIDEFILE
3   #include <stdarg.h>
4   #include <stdio.h>
5   #include <stdlib.h>
6   #include <float.h>
7   #include <math.h>
8   #include <iostream.h>
9   #include "dataobject.h"
10  #include "campaigns.h"
11  #include "saturation.h"
12  #ifdef WIN32
13  #define WIN32_LEAN_AND_MEAN
14  #include <windows.h>
15  #else
16  #include <sys/mman.h>
17  #ifndef min
18  #define min(v1,v2) ((v1)<(v2)?(v1):(v2))
19  #endif
20  #endif
21
22  #ifndef TRUE
23  #define TRUE  1
24  #define FALSE 0
25  #endif
26
27  #if AIX
28  #define  O_BINARY  0
29  #else
30  #include <io.h>
31  #endif
32
33  #ifndef uchar
34  #define uchar unsigned char
35  #endif
36
```

```
typedef struct {
int   eventno;
float unsat_val;
float sat_val;
} sfentry;

#define record_size  (unsigned int)(sizeof(int) + sizeof(float) + sizeof(float))
#define record_size1 (unsigned int)(sizeof(custdata) + custno_size)

#define NO_BUCKETS 4000 // Some reasonable range to bin up the records into
#define CUSTOMER_FENCE 0x40000000  // Use bit two to mark the fence between each customer block

typedef struct {
char    cust_no;
} custdata;

class campaigns;

class sidefile {
public:
            sidefile(char *sfpath,int *maxreturn,dataobject *custs,campaigns *camps);
           ~sidefile();
            inline int   getnextval() { int idx1;
                                                    do { if (buckets[current_bucket] == -1 && 0 == current_bucket--) return 0; // Completed
run
                                  current = buckets[current_bucket];          // Suck the next one up could be end one
                                                    while (current == -1 && 0 != current_bucket--) current = buckets[current_bucket];
                                                    if (current == -1 && 0 == current_bucket) return 0;
                                  buckets[current_bucket] = datavect[current];
                                //   cerr << current << sfptr << endl;
                                  idx1 = get_bucket_index(sfptr[current].sat_val);
                                                    // cerr << sfptr[current].sat_val << endl;
                                                    // Check the head is on the right bucket chain
                                                    // It should always be equal or demotion, ignore promotions just do them next
                                                  if (idx1 < current_bucket)
                                                    { datavect[current] = buckets[idx1]; // Demotion add to head of chain
```

```
73                                  buckets[idx1] = current;
74                                                          }
75                                                          else { //cout << sfptr[current].sat_val << " " << sfptr[current].unsat_val << endl;
76                                                                  return 1;
77                                                                  }
78                                                  } while(TRUE);
79                                  return 1;
80                                  }
81          inline float getcustbudget() { if (!has_budgets || no_campaigns == 0) return -1;
82                                  return budgets[current_budget = current%no_campaigns];
83                                  }
84          inline void  restart() { ::lseek(fhandle3,0,SEEK_SET); current = 0; }
85          inline int   catno() { int eid = sfptr[current].eventno;
86                                  if (eid < 0) eid = -((-eid) & ~CUSTOMER_FENCE);
87                                          else eid = eid & ~CUSTOMER_FENCE;
88                                  return eid; }
89          inline int   catno_inc() { return sfptr[current++].eventno & ~CUSTOMER_FENCE; }
90          inline float get_unsat_value() { return sfptr[current].unsat_val; }
91          inline float get_sat_value() { return sfptr[current].sat_val; }
92                  // Find the bin
93          inline int   get_bucket_index(float val) { register int idx = 1+(int)(floor(0.5+((val * (NO_BUCKETS-2))/max_value)));
94                                  if (val < 0) idx = 0;  // All negatives go in bin 0
95                                                          if (idx == 0 && val >= 0) idx = 1;
96                                  if (idx >= NO_BUCKETS) idx = NO_BUCKETS-1; // Probably unnecessary
97                                                          return idx;
98                                                          }
99          inline void  allocated_catno(void) { sfptr[current].eventno = -sfptr[current].eventno;}
100         inline void select_first() { int eid;
101                                                          // Search backwards from this event for all events for this customer
102                                                          // Assumption is that data was read in as customer primary, secondary
103 sort event_id
104                                                          // therefore, one customer is in a block, and each event is in order.
105                                                          // We have used bit two as a fence on each first record, this allows for
106 a variable
107                                                          // number of targetted events per customer, from 1..n
108                                                          eid = sfptr[current].eventno;
```

```
109                                                                    if (eid < 0) eid = -eid;
110                                                                    // Back up to start of customer block
111                                                                    if (!(eid & CUSTOMER_FENCE))
112                                                                   do { eid = sfptr[current-1].eventno;
113                                                                      if (eid < 0) eid = -eid;
114                                                                       --current;
115                                                                        } while(!(eid & CUSTOMER_FENCE));
116
117                    }
118            inline void  set_sat_value(float sat_value) { sfptr[current].sat_val = sat_value; }
119            inline int   getnext_srt()    {  if ((current+1) > Count) return TRUE;
120                                                int eid = sfptr[++current].eventno;
121                                              if (eid < 0) eid = -eid;
122                                                                    return eid & CUSTOMER_FENCE;
123                                              }
124            inline int   next_custno() { return custno_size == ::read(fhandle3,custrec,custno_size); }
125            inline char *get_custno() { return (char *)&custrec->cust_no; }
126            inline void  set_custbudget(float newbudget) { budgets[current_budget]-= newbudget; }
127            inline void  incnextval() { ++next_choose; }
128            inline unsigned int getnextone() { return next_choose; }
129            inline unsigned int no_records() { return Count; }
130            void debug();
131
132    private:
133    // Promo record
134    int     _catno;       // Catalog number (Negative when allocated)
135    float   _unsat_value; // Initial value before future saturation, includes past saturation
136    float   _sat_value;   // Currently saturated value based on what has been selected
137    // Customer record
138    int     custno_size;
139    custdata *custrec;    // Has to be variable length because we don't know custno size
140
141    // File control data
142    int     fhandle1;     // This is the promotion cost per customer
143    char    *tempname1;   // See promo cost record above
144    int     fhandle2;     // This is customer number (of variable length)
```

```
145   char   *tempname2;     //
146   int    rec_size2;
147   int    fhandle3;      // This is customer budget constraint
148   char   *tempname3;     //
149
150   public:
151   // Sort control data
152   int    zero_cnt;      // Number of zero scores
153   int    neg_cnt;       // Number of negative scores
154   float  max_value;     // Largest input value used for normalising into buckets
155   unsigned int  Count;          // Number of records
156   int    next_choose;   // Index of next to choose
157   int    current_bucket;  // Index to bucket being processed
158   unsigned int    current;       // Index of current record
159   int    has_budgets;   // flag to identify if we are running with individual budgets
160   unsigned int current_budget; // Index of current budget
161   int    no_campaigns;
162   unsigned int *buckets;       // Array to work from
163   unsigned int *datavect;      // Indices into SFdata
164   unsigned int total_customers;
165
166   // Memory mapped file stuff
167   char   *data;          // Pointer to sidefile data mapped
168   sfentry *sfptr;        // Pointer to array
169   float  *budgets;       // Vector of individual budgets
170   #ifdef WIN32
171   HANDLE  fh;            // Memory mapped file handles
172   HANDLE  Maphand;
173   HANDLE  fh1;           // Vector of customer budgets file
174   HANDLE  Maphand1;
175   #else
176   unsigned int size;
177   unsigned int budsize;
178   #endif
179   };
180   #endif
```